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## *Keratella* rotifers found in Brazil, and a survey of *Keratella* rotifers from the Neotropics

by

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### Abstract

Eight Brazilian lakes sampled by Francisco de Assis Esteves and Maria do Socorro R. Ibañez were examined for rotifers. Of the 57 species found, four were members of the genus *Keratella*. A literature search revealed about 15 species and subspecies of *Keratella* recorded from the Neotropics, 11 of these from Brazil.

All known Neotropical *Keratella* rotifers are discussed and figured, with highlights on the endemics. Related species are discussed when confusion may arise with identifications. Taxonomic details of specific significance are listed in order of importance, and the state of expert consensus about this genus is given. Ecology and distribution of these rotifers are also discussed.

**Key words:** Rotifers, *Keratella*, distribution, Neotropics, South America.

### Resumo

Oito lagos brasileiros pesquisados por F. A. Esteves e M. S. R. Ibañez foram examinados a fim de determinar as espécies de Rotifera presentes nos mesmos. Entre as 57 espécies distintas que foram constatadas nos lagos, 4 foram membros do gênero *Keratella*. Pesquisa na literatura científica revelou registros de cerca de 15 espécies e subespécies de *Keratella* nas regiões neotrópicas, sendo 10 espécies registradas no Brasil.

Fornecem-se figuras de todas as espécies de *Keratella* atualmente registradas nas regiões neotrópicas, com ênfase às espécies endêmicas. Discutem-se casos de possível confusão entre espécies parecidas. Detalhes taxonômicos importantes são listados em ordem da sua importância, e um resumo fornecido do estado atual das opiniões dos especialistas sobre o taxon. Discutem-se brevemente também a ecologia e áreas de distribuição destes rotíferos.

## 1. Introduction

Brazilian waters are the most documented Neotropical waters for rotifer records (AHLSTROM 1938; GILLARD 1967; GREEN 1972a; HAUER 1953, 1965; KOSTE 1972a, 1972b, 1973, 1974; KOSTE & HARDY 1984; KOSTE & ROBERTSON 1983; KOSTE et al. 1984; SCHADEN 1978). (For the purposes of this paper, Neotropics will denote the biogeographical realm south of the Tropic of Cancer). The Amazon occupies most of the literature but coastal Brazilian lakes are also noted (DUSSART et al. 1984). Neotropical rotifer distribution is discussed in a global context in several papers (DE RIDDER 1981; GREEN 1972b; DUMONT 1983; DUSSART et al. 1984). Additionally, regional papers have shown distribution patterns and geographical similarities between various Neotropical species compositions (CARLIN-NILSON 1935; LEENTVAAR 1975, 1979; MURRAY 1913; and THOMASSON 1955, 1980).

Although preliminary documentation is becoming available, Neotropical rotifers in regional environments are not yet fully explored (DUSSART et al. 1984). KOSTE & DE PAGGI (1982) show 15 references for Brazilian waters, and at least four more references are available since 1982. Argentina is the second most documented country for rotifers, for which nine references are noted in KOSTE & DE PAGGI (1982), and at least one other is available since 1982. Although Argentina and Chile are considered part of the Neotropics, their climate must be considered temperate.

Knowledge of the systematics and ecology of Brazilian Rotifera is incomplete but improving. Taxonomic studies and baseline data of regional Neotropical rotifers are also scarce. As more sampling takes place in the region, investigators should be encouraged to properly identify or describe the rotifers encountered in their zooplankton samples. Some available references useful to interested researchers are KOSTE (1978) and RUTTNER-KOLISKO (1974).

## 2. Description of Study Area

This author found 57 species of rotifers in zooplankton samples from southeastern Brazil (State of Rio de Janeiro) collected by Dr. Francisco Esteves in 1983, and from northeastern Brazil (State of Maranhão) investigated by Dr. Maria S. R. Ibañez in 1984.

The lakes that contained *Keratella* rotifers include:

Number	Name	Approx. Coordinates	Sample date
1.	Lagoa de Cima	(21 - 45S 041 - 30W)	26 Jan & 16 Sep 1983
2.	Lagoa Carapebús	(22 - 13S 041 - 37W)	26 Jan 1983
3.	Lagoa Comprida	(21 - 17S 041 - 39W)	26 Jan 1983
4.	Lagoa Cabeunas	(22 - 18S 041 - 42W)	14 Sep 1983
5.	Lago Açú	(03 - 50S 044 - 55W)	Nov 84 & Oct 1985
6.	Lago Viana	(03 - 50S 044 - 56W)	2 Oct 1985

Lakes 1 - 4 are in the zoogeographical province of Tupi. Lakes 5 & 6 are in the zoogeographical province of Hylaea (FITTKAU 1969). ESTEVES et al. (1984) documents physical and chemical conditions in the Rio lakes.

Chapter 4. lists all known *Keratella* rotifers from the Neotropics, with lake numbers beside the rotifers found by me in Brazil. *Keratella procurva* is a new record for Brazil. All known *Keratella* rotifers are subsequently discussed, in context of their distribution in the region.

## 3. Taxonomic Considerations of the genus *Keratella*

Rotifers of the genus *Keratella* are common and often abundant around the world. Taxonomy within the genus is based on the number and pattern of lorica facets, relative proportional size of body widths (anterior and posterior), relative lengths and number of caudal spines, and placement of posterior spine insertions. Six anterior spines are always present (with one non-neotropical exception *Keratella reducta* HUBER-PESTALOZZI, 1929). Two elements of morphology that were once considered, but are probably not now useful taxonomically are: 1) number of facets visible on lorica, regardless of pattern, and 2) pustulation or granulation of the ventral or dorsal plates.

Length of spines, pattern and number of facets distinguishable on the lorica vary tremendously within this genus (AHLSTROM 1943). KOSTE (1978, 1979) distinguishes three broad Formenkreise: *quadrata*, *valga-tropica* and *cochlearis*. He further maintains that without additional study, many other species groups with morphological stability remain unranked. Considering the present uncertainties about taxonomic criteria for speciation, RUTTNER-KOLISKO (1974) suggests three groups: *quadrata*, *serrulata* and *cochlearis*. Although this author does not necessarily agree with Ruttner-Kolisko's speciation criteria and overall concept of rotifer taxonomy, her groups are used in this paper because of their functional and descriptive nature. Representative dorsal lorica plate patterns of each group are illustrated by their lead species noted in Figures 1k, 1l, and 1c & d respectively.

The first group, *quadrata*, representatives in the Neotropics are *K. quadrata* (most forms and variations including *frenzei*), *K. kostei* and *K. tropica* (including form *brehmi*). Perhaps *Keratella procurva*, *K. lenzi* and *K. nhamunda* are transitional into the *serrulata* group. The *serrulata* group in South America, contains *K. serrulata serrulata*. The spineless *serrulata* f. *curvicornis* has not been recorded in the Neotropics. Transitional animals from *serrulata* into *cochlearis* are *K. nhamunda*, *K. americana*, *K. yamana*, and *K. ona*. The *cochlearis* group contains *K. cochlearis* (and forms), *K. tecta* and *K. thomassoni*.

Table 1: *Keratella* species groupings for Neotropical rotifers (partially from RUTTNER-KOLISKO 1974)

<i>quadrata</i> group	<i>serrulata</i> group	<i>cochlearis</i> group
<i>quadrata</i>	<i>serrulata</i>	<i>cochlearis</i>
<i>quadrata frenzei</i>		
	<i>procurva</i> . . . . . <i>ona</i>	
<i>tropica</i>		<i>tecta</i>
<i>lenzi lenzi</i>		
<i>tropica brehmi</i>		<i>thomassoni</i>
	<i>nhamunda</i> . . . . . <i>americana</i>	
<i>kostei</i>	<i>yamana</i>	

(Species peculiar to the Neotropics are inserted into RUTTNER-KOLISKO's scheme where I felt most appropriate. However, this scheme may still be inadequate to show the specific relationships between rotifers in this region).



These 'groupings' are useful when species characteristics cannot be distinguished. Complete documentation of environmental, ecological and chemical parameters of rotifers by non-specialist researchers will ultimately contribute to the eventual definition of species which are presently indistinguishable by morphology alone. Table 1. shows RUTTNER-KOLISKO (1974) species groups, and known Neotropical rotifers, with insertions of new Neotropical rotifers into her arrangement.

#### 4. List of *Keratella* rotifers found in Neotropics

There follows a list of all species of *Keratella* rotifers recorded from the Neotropics. Records of the four species from the present study are indicated by the lake numbers in parentheses.

<i>Keratella americana</i> CARLIN	(1, 4, 5, 6)
<i>Keratella cochlearis cochlearis</i> GOSSE	(2, 4, 5)
<i>Keratella kostei</i> DE PAGGI	
<i>Keratella lenzi lenzi</i> HAUER	(4, 5)
<i>Keratella nhamunda</i> KOSTE	
<i>Keratella ona</i> BOLTOVSKOY & URREJOLA	
<i>Keratella procurva procurva</i> (THORPE)	(3)
<i>Keratella quadrata quadrata</i> (MÜLLER)	
<i>Keratella quadrata frenzeli</i> (ECKSTEIN)	
<i>Keratella serrulata serrulata</i> (EHRENBERG)	
<i>Keratella tecta</i> (GOSSE)	
<i>Keratella thomassoni</i> HAUER	
<i>Keratella tropica tropica</i> (APSTEIN)	
<i>Keratella tropica</i> f. <i>brehmi</i> (KLAUSENER)	
<i>Keratella yamana</i> BOLTOVSKOY & URREJOLA	

#### 5. Interpretation of Species List

PEJLER (1977) lists 24 *Keratella* species as valid, yet DUMONT (1983) now records 37, an increase of 13 in just six years. This increase tends to demonstrate that the thinking about true speciation and systematics as it applies to rotifers has changed. Biometric analysis has improved the way we look at rotifers, enabling us to see two or more morphologically similar species groups where only one was thought to exist previously. In addition, individual samplings have increased during this time, allowing for a larger number of samples and larger areas to be investigated.

DUMONT (1983) suggests that only a small minority *Keratella* rotifers may truly be distributed worldwide. Most rotifer identifications have followed major handbooks rather than taking into consideration essential taxonomic deviations within generic groups. As a result, 'endemism is concentrated near both poles, with no endemism in the tropics and

little in the subtropics.' He considers 12 *Keratella* species as being valid for South America, with as many as six New World endemics. More endemics will probably be encountered as closer scrutiny is given to existing and newly discovered animals.

Of the 57 different species found by this author, only four were *Keratella* rotifers. Other authors have recorded a total of 15 species of *Keratella* from the Neotropics, 10 of them from Brazil (KOSTE & DE PAGGI 1982; KOSTE & ROBERTSON 1983).

#### 6. *Keratella* Species and Distribution

##### 6.1 *Keratella americana* CARLIN, 1943; Fig. 1a & b.

SYN.: *Anuraea stipitata* ZELINKA, 1907, *K. stipitata*, HARRING 1913, *K. stipitata*, EHRENBERG after COLLIN et al. (1912) and after HUDSON & GOSSE (1889). *K. gracilentia* AHLSTROM, 1943, *K. lenzi* f. *caudata*, KOSTE 1972.

*Keratella americana* has particular dorsal lorica sculpturing with four median unpaired facets and no sub-facets, which especially characterize this animal. It is less than 280 µm in length. This rotifer often displays stippling or very tiny spinules on the caudal spine or margins of the lorica, although these are not species-specific features. Many of the specimens in the present samples had such stippling on the ventral plate, with spinules on the caudal spine.

The dorsal lorica pattern is the only pronounced characteristic of this animal, but because of smooth or vanishing plate patterns, it may be difficult to determine the species of certain animals. According to RUTTNER-KOLISKO (1974), morphologically, it fits between *Keratella serrulata* and *Keratella cochlearis* species groups. *K. yamana* is probably the closest regional relative. *K. americana* has also been found by GILLARD (1967), GREEN (1972a), HAUER (1965), KOSTE et al. (1984), KOSTE & HARDY (1984), SCHADEN (1978), and others. KOSTE (1972b) found it in about half of the lakes sampled in the Amazon region. It inhabits many open bodies of acidic fresh waters, at temperatures up to 34 °C. Perhaps replacement may take place between *K. cochlearis* and *K. americana* in tropical environs (RUTTNER-KOLISKO 1974). Other records for this rotifer are from Venezuela, Chile, Surinam, Panama, and Honduras (KOSTE & DE PAGGI 1982).

##### 6.2 *Keratella cochlearis* (GOSSE), 1851; Fig. 1c & d.

SYN.: *Anuraea cochlearis* GOSSE, 1851, *A. stipitata* (EHRENBERG) after CARLIN (1943).

*Keratella cochlearis* is a very common rotifer species. Its dorsal lorica is sculptured in a particular fashion, with one median frontal facet; and when visible, always has at least one pair of nearly symmetrical median (anterocarinal) facets (AHLSTROM 1943). Its size varies from less than 80 µm to over 320 µm in length (KOSTE 1978).

Even though there is no consistent relationship between morphological variation and sexual cycle, variation of caudal spine lengths and lorica plates (facets) within species groups and populations of single species over time can be expected (PEJLER 1980; RUTTNER-KOLISKO 1974). Relationships between water temperature and caudal spine



lengths have been shown by CARLIN (1943) and HILLBRICHT-ILKOWSKA (1972, 1983). Conversely, according to the observations of PEJLER (1962), temperature is not responsible for significant local variation.

Several researchers have found *K. americana* and *K. cochlearis* coincident in samples (KOSTE et al. 1984; KOSTE & HARDY 1984; KOSTE & ROBERTSON 1983), demonstrating that overlap of suitable environs can still be expected to contain both species. This rotifer is cosmopolitan, found in waters from oligo- to mesotrophic nature, in temperatures up to 30 °C. Records for this animal include Brazil, Colombia, Venezuela, Argentina, Peru-Bolivia, Panama, Honduras and Paraguay (KOSTE & DE PAGGI 1982; KOSTE 1986).

The characteristic sculpturing of the dorsal lorica may be partially obscured by pustulation or scale-like ornamentations. In these cases, analysis of the existing population of related rotifers is required. Specific differentiation conformity still eludes professional rotiferologists. Various forms and subspecies have been described from this region with varying merit to specific status (*K. cochlearis* f. *post-curvata* THOMASSON, 1957). Expert consultation may be the only sure way to identify difficult specimens.

### 6.3 *Keratella kostei* PAGGI, 1981; Fig. 1e.

SYN.: None.

Its appearance, with broad 'waist' and narrower 'neck' area, place this rotifer in the *quadrata* species group. However, unlike others in the group, its antero-lateral spines are longer than the medians and antero-intermediaries. Also, the posterior margin of the lorica has a double rim, with facets (?) in the margin slightly resembling *K. lenzi*. The dorsal lorica shows no facets or particular sculpturing.

It was found in two of four lakes sampled by PAGGI (1981) in Argentina, and may be restricted to Patagonian tableland lakes. Length of about 130 µm.

### 6.4 *Keratella lenzi lenzi* HAUER, 1953; Fig. 1f & g.

SYN.: *Keratella valga* f. *brehmi* AHLSTROM, 1943.

*Keratella lenzi lenzi*, first described from Brazil, is usually less than 150 µm long, and is identified in the lateral profile of the dorsal lorica by as many as three pairs of thin oval dorso-ventral facets (plates). Three pronounced median facets, the posterior most being elongated, show resemblance to the spineless *K. quadrata* rotifer. In its habitat, this rotifer also resembles *K. tecta*, *K. testudo*, *K. ticinensis*, *K. cruciformis* and *K. tropica brehmi*. This rotifer can be regarded as falling between *quadrata* and *serrulata* species groups.

KOSTE (1972b) found this animal in 10 % of his samples in the Amazon. HAUER (1965), KOSTE & ROBERTSON (1983), KOSTE et al. (1984) and SCHADEN (1978) have also reported this rotifer from the Amazon. KOSTE & DE PAGGI (1982) report this rotifer from Argentina, Antilles, Venezuela, Paraguay and Panama. DUMONT (1983) shows this rotifer as tropical, while KOSTE (1972b) reports it from Florida, Brazil, Africa, Madagascar, Cambodia [Kampuchea], Australia and Ceylon. It is found in tropical fresh waters in moderately acidic environs, usually below 30 °C.

### 6.5 *Keratella nhamunda* KOSTE & ROBERTSON, 1983; Fig. 1h.

SYN.: *K. americana nhamundaiensis* KOSTE, 1982.

In their redescription, KOSTE & ROBERTSON (1983) suggest this animal may be a phylogenetic link between the species groups *americana* and *procurva*. The postero-median facet is closed in this species as in *K. procurva*, while it is open in *K. americana* according to the redescription. Additionally, *K. procurva* always has a reduced or absent left caudal spine, supporting the postulation about the origins of the unsymmetrical looks of *K. nhamunda*. Longitudinal striations on the dorsal lorica may not be genetically propagated.

This rotifer was found at the mouth of the Rio Nhamunda in 1975, and was discussed as *K. americana nhamundaiensis* in BRANDORFF et al. (1982). KOSTE & ROBERTSON (1983) record it also from Lago Camaleão, within the heavily vegetated, fresh water river flow.

### 6.6 *Keratella ona* BOLTOVSKOY & URREJOLA, 1977; Fig. 2a.

SYN.: *K. cochlearis* f. *valdiviensis* THOMASSON, 1957 (?), *K. valdiviensis* (THOMASSON, 1957 after HAUER 1958) (?).

This rotifer is difficult to classify in the scheme chosen for this paper. The median frontal area facets on the dorsal lorica, and the distinctness of the unpaired, symmetrically shaped facets, link this rotifer in the *serrulata* group. The original describers however, believe it to be possibly linked to *K. procurva*; yet its singular symmetrical caudal spine suggests that it be placed between *serrulata* and *cochlearis* species groups. This species may also lack the singular caudal spine (BOLTOVSKOY & URREJOLA 1977). A total of 26 facets are visible (lateral and marginal facets), exceeding all but *K. yamana* in number. Sculpturing of the lorica is apparent on the originally described specimens, and it varies from 140 to 190 µm long.

BOLTOVSKOY & URREJOLA (1977) relate this animal to *K. procurva*. KOSTE (1978) places this animal in Formenkreis *americana*, agreeing with the scheme RUTTNER-KOLISKO (1974) uses, that probably places it between the *serrulata* and *cochlearis* groups. It is found in *Sphagnum* bogs in Tierra del Fuego.

### 6.7 *Keratella procurva procurva* (THORPE), 1891; Fig. 2b.

SYN.: *Anuraea procurva* THORPE, 1891, *K. valga* after EDMONDSON & HUTCHINSON 1934.

THORPE (1891) described the animal as *Anuraea procurva* based on the lateral shape of the lorica. The presently accepted distinguishing features of this species are the particular placement of caudal spines unequal in length, and the pentagonal posterior median facet. Variation of *K. procurva procurva* is influenced heavily by water temperature (BERZINS 1953). It can easily be mistaken for *K. serrulata serrulata*. Systematically, it probably falls between *quadrata* and *serrulata* species groups. It is usually less than 180 µm long.

DUMONT (1983) does not list this animal from South America, however, DE RIDDER (1977) records it from the Caribbean and discusses its presence in India and Sumatra (EDMONDSON & HUTCHINSON 1934; HAUER 1937) under the name *K. valga valga*. Other authors have found this rotifer in Malaysia and Singapore, Australia, Venezuela and Argentina (BERZINS 1982; FERNANDO & P.-ZANKAI 1981; KOSTE 1979; KOSTE & DE PAGGI 1982; DE PAGGI 1973).



This animal occurs in eutrophic tropical and subtropical waters, also at about pH 8 (KOSTE 1978). Several of these rotifers were found by this author in Lake Comprida, Brazil. This is a new record for this animal in this region of the Neotropics and in Brazil.

**6.8 *Keratella quadrata quadrata* (MÜLLER), 1786; Fig. 2c.**

SYN.: *Brachionus quadratus* MÜLLER, 1786, *Anuraea squamula* EHRENBERG 1832, *Anuraea aculeata* EHRENBERG, 1832.

There are a great many forms and subspecies of this central morphotype of the genus, and consequently on the *quadrata* species group. The lorica has four regular, unpaired median facets; and is usually accompanied by two posterior spines of slightly or greatly unequal lengths. (The right spine is always the longer spine). Posterior spines insertion is 'outside' (*quadrata*) rather than 'inside' (*valga*). Posterior spines, lorica facets and lorica lengths all may vary independently. Variations in total size, outline of the body and thickness and structure of the lorica are very common and can be significant. Different forms vary from 160 µm to 480 µm in length.

RUTTNER-KOLISKO (1974) regards *frenzeli* as a form, while KOSTE & DE PAGGI (1982) show var., to be considered subspecies, *frenzeli* (Fig. 2i). It is known from Bolivia and Peru.

There are a number of related species, many of which occur in tropical environs. *K. valga* and *K. tropica* both have unequally reduced caudal spines, yet cf. *valga* is only recorded once in the Neotropics (KOSTE 1986). *K. tropica* includes an additional posterior median remnant on the dorsal lorica that is used to distinguish it from *quadrata*. Spineless forms of *K. quadrata* may be confused with *K. ticinensis* (presently unknown in the Neotropics), and *K. hiemalis*, although the latter is confined to cooler waters and the northern hemisphere (PEJLER 1977). HARRING (1914) reports this animal from Panama, while other records in the Neotropics are from Paraguay, Brazil, Bolivia and Peru.

This mostly pelagic rotifer can be thought of as cosmopolitan, inhabiting eutrophic as well as oligotrophic environs and inland salt waters. It is also tolerant of wide pH limits. To date, there is agreement about correlation between temporal variation, caudal spine lengths and total animal size. Other variations such as facet shapes and unsymmetrical spine growth still elude correlations to other measurable factors. The *frenzeli* form, or var. *frenzeli* according to KOSTE (1978), is found in large lakes at low temperatures, and can be 500 µm in length.

**6.9 *Keratella serrulata serrulata* (EHRENBERG), 1838; Fig. 2d.**

SYN.: *Anuraea serrulata* EHRENBERG, 1838, *K. falcata* EHRENBERG, 1838.

This animal is central to the *serrulata* species group of RUTTNER-KOLISKO (1974). Three dorsal median facets are usually pronounced, with the posterior most facet always being a heptagon. Two postero-carinal facets join to form a ridge from the heptagonal facet to the caudal end of the animal. It resembles *K. procurva*.

A spineless form exists, and is often found coincident with this typical form. However, this spineless form *K. serrulata* f. *curvicornis* has not been found in the Neotropics. KOSTE (1978) and DUMONT (1983) show this animal as cosmopolitan. It is usually found in humic waters, specifically *Sphagnum* pools, with overall length up to 300 µm.

**6.10 *Keratella tecta* (GOSSE), 1851; Fig. 2e.**

SYN.: *K. cochlearis* var. *tecta* (GOSSE), 1886, *K. cochlearis* var. *tecta* f. *typica* (LAUTERBORN), 1900, *K. stipitata tecta* CARLIN, 1943.

This animal strongly resembles *K. cochlearis cochlearis*, but without a caudal spine, or with a very reduced spine. HOFMANN (1980, 1983) shows that in Lake Plußsee, regardless of lorica pattern, *K. tecta* was distinct from *K. cochlearis*. He found no intermediary or transitional forms. As DUMONT (1983) puts it, a persistently distinct and cohabiting taxon should be a good species, as suggested by HUTCHINSON (1967). KOSTE (1978) shows *tecta* as var., while PEJLER (1977) and DUMONT (1983) do not list it as anything other than f. *tecta* of *K. cochlearis*. However, KOSTE & POLTZ (1984) show *K. tecta* as a valid species.

**6.11 *Keratella thomassoni* HAUER, 1958; Fig. 2f.**

SYN.: None.

This animal resembles *K. cochlearis* and *K. irregularis*. The lorica pattern may be different enough from these rotifers to warrant speciation, however PEJLER (1977) offers questions to its validity, as its foundation pattern is very similar to that of *K. irregularis* f. *angulifera* (LAUTERBORN), 1900. It is among the *cochlearis* species group, and is only recorded from Chile and Argentina. Length can be 140 µm long.

**6.12 *Keratella tropica tropica* (APSTEIN), 1901; Fig. 2g.**

SYN.: *Anuraea valga* f. *tropica* APSTEIN, 1907, *Anuraea aculeata* MURRAY, 1913, *K. valga* f. *tropica* EDMONDSON & HUTCHINSON, 1934, *K. quadrata valga* f. *asymmetrica* UENO, 1938.

This rotifer is characterized by a postero-median remnant, located on the median facet line of the dorsal lorica. Additionally, the conspicuous narrowness of the posterior portion of the lorica, (the anterior 'neck' is always wider than the posterior 'waist'), and the 'inside' insertion of the posterior spines contribute to the species diagnosis. The left posterior spine is always reduced or absent.

It can easily be confused with *K. valga*, although *valga* is found in eurythermic unstratified waters (alpine pools). The distinguishing features between these rotifers is the habitat, slight difference in size, and the presence or absence of the posterior remnant. KOSTE (1986) records the only Neotropical record of *K. cf. valga* from an uncharacteristic environ in Paraguay.

RUTTNER-KOLISKO (1974) characterizes *K. tropica* as a warm stenotherm, found in the tropics. She includes it in the *quadrata* species group. While AHLSTROM (1938) notes that it may replace *K. quadrata* in the tropics, BERZINS (1955) also found that *K. valga* and *K. tropica* replace each other geographically. PEJLER (1977) notes that these rotifers are a good example of sister species vicariating geographically, and that even though LEENTVAAR (1961) found *K. tropica* in the Netherlands subsequent to Berzins findings, This case was possibly a singular one or a recent immigration.

Up to 340 µm in length, it is pantropical, found also in warmer temperate regions. Records include Argentina, Chile, Peru, Panama, Paraguay and the Amazon in Brazil (KOSTE et al. 1984).



KOSTE & DE PAGGI (1982) show the spineless form as *K. tropica* f. *brehmi* (KLAUSENER) (Fig. 2j), and record it from Brazil and Argentina.

### 6.13 *Keratella yamana* BOLTOVSKOY & URREJOLA, 1977; Fig. 2h.

SYN.: None.

This animal was found coincident with *K. ona* in two small *Sphagnum* bogs, in Tierra del Fuego, Argentina. (Both rotifers are only known from one locality). The median frontal area facets on the dorsal lorica, and the distinctness of the unpaired, symmetrically shaped dorsal median facets, tend to place this animal in the *serrulata* species group (BOLTOVSKOY & URREJOLA 1977; RUTTNER-KOLISKO 1974).

It is probably also closely related to *K. americana*. It has a scale-like ornamentation on the dorsal lorica, (probably not a specific characteristic), and 28 facets on the dorsal lorica; more than other related species. Specimens are from 138 to 150 µm long.

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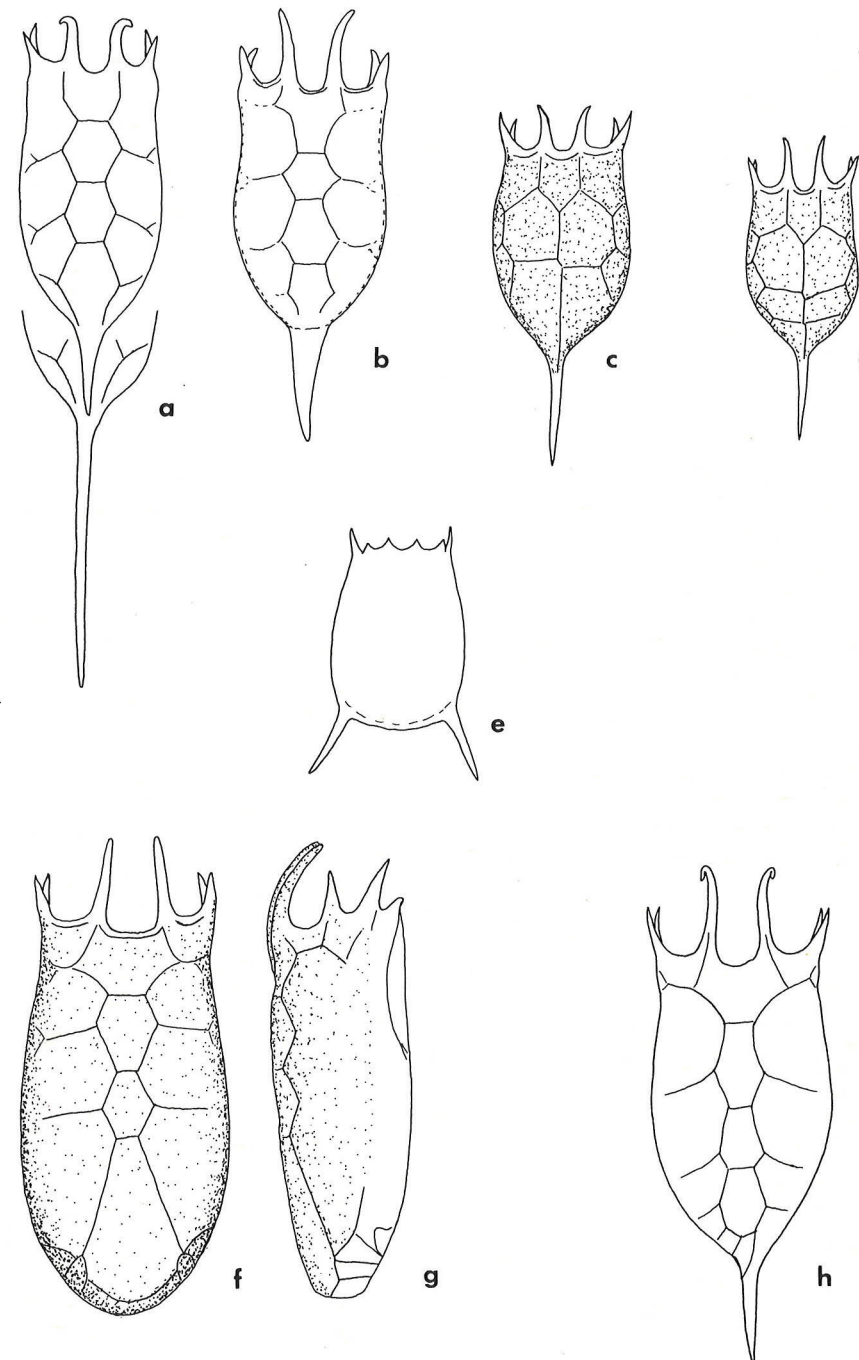


Fig. 1:  
*Keratella* species dorsal lorica patterns — a & b) *K. americana* CARLIN modified after KOSTE (per. com.) and KOSTE & TOBIAS (1987), c & d) *K. cochlearis* (GOSSE) after KOSTE (per. com.), e) *K. kostei* PAGGI, after PAGGI (1981), f & g) *K. lenzi lenzi* HAUER, h) *K. nhamunda* KOSTE & ROBERTSON, after KOSTE & ROBERTSON (1983).



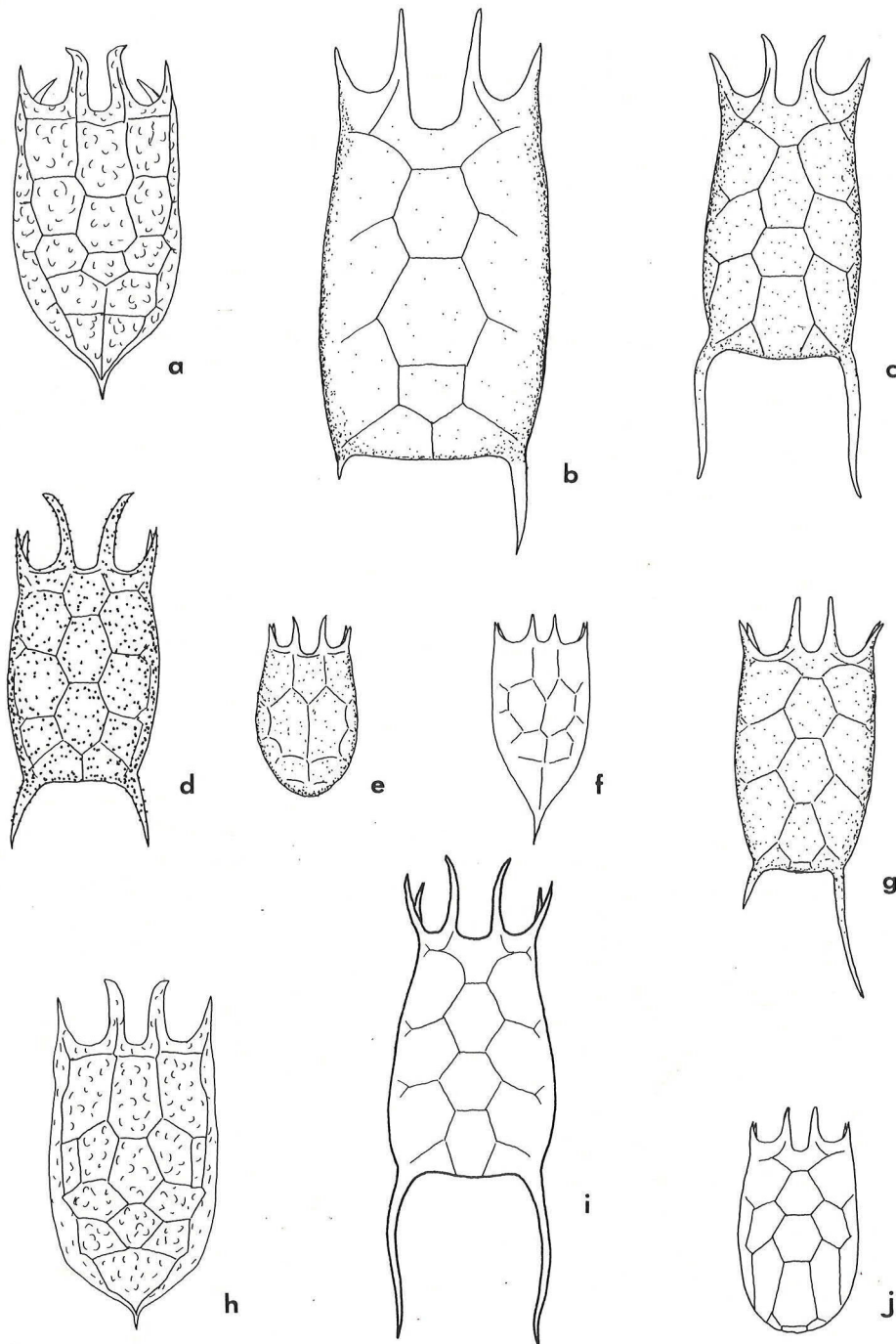


Fig. 2:

*Keratella* species dorsal lorica patterns – a) *K. ona* BOLTOVSKOY & URREJOLA, after BOLTOVSKOY & URREJOLA (1977), b) *K. procurva* (THORPE), c) *K. quadrata quadrata* (MÜLLER) modified after KOSTE (per. com.), d) *K. serrulata* (EHRENBURG), e) *K. tecta* (GOSSE) modified after KOSTE (per. com.), f) *K. thomassoni* HAUER, after PAGGI (1981), g) *K. tropica* (APSTEIN), h) *K. yamana* BOLTOVSKOY & URREJOLA, after BOLTOVSKOY & URREJOLA (1977), i) *K. quadrata frenzeli* (ECKSTEIN) modified after KOSTE & POLTZ (1984), j) *K. tropica* f. *brehmi* (KLAUSENER) after AHLSTROM (1943).